A UPNP-BASED VIDEOCONFERENCE SYSTEM TO SUPPORT HOME TELECARE SERVICES

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Abstract: This paper presents a home healthcare system that implements videoconference calls based on the UPnP standard to support telecare services. Firstly, it reviews the state of the art of telecare and applied technologies. Our approach describes a system architecture that provides capabilities to integrate different telecare services in a residential gateway. It addresses the challenge of the integration of patient relatives and friends in the telecare service to enhance the user's confidence. We propose a videoconference system to communicate healthcare actors (patient, nurse, doctor and relatives) based on a widespread standard that enables an automatic discovery of multimedia services and presents a seamless streaming negotiation.

1 INTRODUCTION

The progressive ageing population, the need of controlling the healthcare costs and the expansion of Internet broadband are increasing the interest to develop telecare and telemedicine. Telecare utilises information and communication technologies to transfer medical information for the diagnosis and therapy of patients in their place of domicile while telemedicine is related with the delivery of clinical care at distance (Norris, 2002). In some type of patients with reduced mobility, like elderly or handicapped people, telecare makes better medical attention possible.

To reduce the difficulties currently suffered by these people when obtaining the telecare services, it is required to the healthcare actors maintain a reliable relationship and the ICT (Information and Communications Technologies) equipment complies a widespread standard. Due to the need of friendship and affection while their social isolation, is important to involve the relatives and friends in telecare service.

However, the current telecare systems often ignore these social issues and also sometimes lack adequate interoperability.

The telecom companies have begun to deploy Residential Gateways (RGW) in the last years to provide different remotely managed services. RGW is a small computer with a software platform to manage many services at home, like video-on-demand, telealarm, etc. The OSGi specification (OSGi Alliance, 2009) provides an architecture for remote control of a platform and provides an execution environment for services.

Our approach presents a model of video-conference system to support telecare services in a RGW running under OSGi. The audio/video calls functionality, included in multimedia services supported by the RGW, is based on the UPnP AV (Universal Plug & Play for Audio-Video) standard because provides a flexible and modular framework to provide multimedia communications under a well-known standard. The health data transmission is based on the HL7 standard to allow the communication with the mayor possible number of external informatics health systems.

In Section 2, the state of the art of telecare is reviewed. Our proposal is presented in Section 3, describing the platform architecture and the multimedia subsystem design. The last section closes the paper with future work and conclusions.

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2 STATE OF THE ART

Current state of the art of telecare/telemedicine and the technologies involved are detailed next briefly.

2.1 Related Research on Telecare and Telemedicine

Some telemedicine and telecare approaches based on OSGi can be founded in the literature (Clemensen, 2004; Chen, 2005; Wang, 2006) but not integrate a video-conference service in the software platform.

The Seguitel system (Plaza *et al.*, 2009), is a social and healthcare service platform for telecare developed by Telefónica I+D based on OSGi and its own middleware. It's oriented to provide services designed under a methodology that ensure an SLA (Service Level Agreement) but this approach add more middleware layers besides doesn't deal with the healthcare standard interoperability.

2.2 Applied Technologies

A brief overview of the applied technologies and standards in our approach are detailed next.

2.2.1 OSGi Framework

OSGi framework is a Java-based open, common architecture for network delivery of managed services specified by the OSGi Alliance. The services are added through software components called bundles.

The platform carries out a complete management of bundles life cycle: install, remove, start, stop and update. The bundles are Java applications running on the same JVM (Java Virtual Machine) that can share code.

2.2.2 UPnP AV Standard

Videoconference system allows the communication between the patient and the assistant or medical people as well as his relatives during the telecare service use. The videoconference functionality needs a multimedia device infrastructure managed by the RGW. The UPnP (UPnP Forum, 2009) is an initiative of Microsoft and is developed by UPnP Forum. The main target of this protocol is providing a seamless connectivity between a vast variety of devices and computers over virtually any type of IP connection.

The UPnP AV is a standardized UPnP architecture for multimedia systems that presents the next advantages:

- It is a widely spread standard to develop multimedia home networks.
- It allows an automatic discovery of multimedia services.
- There are open source libraries of the standard available.
- Low CPU usage for the streaming negotiation & management.

Other approaches are based on SIP and IMS (Haber & Gerdes, 2007) but it seems a complex solution and too heavy for low cost devices.

3 VIDEOCONFERENCE SYSTEM BASED ON UPnP TO SUPPORT TELECARE SERVICES

Firstly, we present the telecare service platform. Then we detail the design and implementation of the UPnP-based videoconference system.

3.1 Overview

Telecare means to integrate patient-oriented services, like telecommunication, health data transmission and home automation. Our proposal tries to provide an interoperable and scalable solution. The system is divided in three basic subsystems: home automation, telemedicine and multimedia subsystem. These elements are managed by a RGW running with Linux and OSGi framework that make possible to host the different services which can be managed remotely by the telecare or access provider.

The multimedia devices used in the home telecare service consist of a television or LCD monitor connected to the RGW, with a webcam with incorporated microphone. The patient is seated in front of the monitor during the telecare session near of the health measuring instruments.

An architecture schema for the e-health platform is shown in Figure 1, where the multimedia subsystem is colour in grey.

The task of eManager bundle is to manage the different profiles of the several devices and the personal recorded data. It offers a service to the rest of bundles to get health data while keeping a secure and logical access.

The telemedicine subsystem is formed by the software, protocols and home health measuring instruments, for example a personal scale or a blood-pressure monitor. After the patient takes blood

pressure reading or weighs, the devices connect to the RGW by Bluetooth and send it the measure to be saved in a local SQL database.

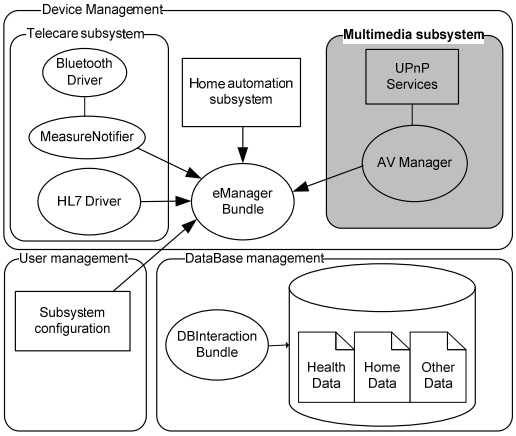

Figure 1: Architecture schema for the home telecare platform.

The patient data must be transmitted to the medical center following a messaging standard. HL7 (Hammond, 1993) is a widely applied protocol to exchange clinical data in the industry. Moreover, there are open source tools available to process and transmit HL7 messages (HAPI, 2009; Mirth Corp., 2009). These messages are sent from the home to the medical center by the RGW, received by a medical information system and displayed to the doctor in his computer.

3.2 Telecare Scenarios

Some scenarios proposed for the telecare service are:

1) An elderly man has a medical citation with the doctor to review his heart health.
2) An elderly woman that lives alone received a video call from an assistant or relative to take care about her.
3) A nurse demonstrates how to inject insulin to a newly diabetes diagnosed patient.

Previous telecare proposals are often organized not taking into account the communication with the relatives and friends of the patient. But according to several studies, sometimes the elderly or dependent people are reticent to use telecare services because they do not personally know the operator or contact person in the telecare service centre. So we can improve the usability of the service if firstly the patient contacts to his familiar. In the first scenario, for example, the doctor initiates a video call with the patient to remotely check some readings about the heart health, like the blood-pressure, heart rate or the weight. The RGW keeps an address list of relatives and friends and the patient can communicate with them if he doesn't feel well or call to emergency service in a serious situation.

3.3 Multimedia Subsystem for e-Health Platform

There are several UPnP frameworks available as open source software. Cybergarage (Satoshi, K., 2009) has been chosen because of its Java libraries and compatibility. This framework provides basic UPnP functionalities for service discover, eventing, controlling and presenting.

Our approach is based in well known multimedia and network standards: UPnP, HTTP (HyperText Transfer Protocol), MPEG-2 and SIP (Session Initiation Protocol). This protocol makes connect remote devices possible in dynamic environments like home access networks because the IP address usually is received dynamically and the link status would be variable.

The AV conference subsystem is design as a symmetric architecture, so the RGW and e-Health provider server will be running the same modules. Audio and video content are transmitted in MPEG-2 format for both parts in a HTTP session after the negotiation. A brief summary of the subsystem modules is presented next:

- UPnP Media Server: it implements a Media Server with UPnP capabilities, to register and server previously recorded AV content or real-time streaming offered by a video camera like a webcam, for example.
- UPnP Media Renderer: it implements a Media Render with UPnP capabilities. It deals with receiving the audiovisual streaming and provides the URL to connect the AV stream.
- AV Control Point: it implements an AV UPnP client. This module acts as control point between multimedia devices that deal with the transfer of audiovisual streaming or content. Its tasks are mainly to register UPnP servers and renderers, to configure outgoing audiovisual streaming between e-Health provider Media Server and patient RGW Media Renderer or to configure incoming audiovisual streaming.
- AV Manager: this module is a front-ed for the AV Conference subsystem that permits to offer an external high level API to set video calls and one-way AV streaming.

4 EXPERIMENTS

First experiments are being implemented in a laboratory with two local networks simulating the communication between two environments, like the patient home and the assistant office.

The simulated RGW is running in a low resources computer with an Intel Pentium Celeron CPU, 512 MB memory and Debian Linux. Apache Felix, a OSGi R4 Service Platform compliant implementation released under an open source license is chosen as the RGW software platform running over a Sun JVM. The AV UPnP software is implemented by a branched version of Cybergarage Java libraries. A simple USB webcam with incorporated microphone is used to acquire multimedia data.

5 CONCLUSIONS AND FUTURE WORK

A new videoconference system to support telecare services has been presented. Our approach tries to integrate the health data transmission service with the audio/video calls besides advancing in the health data interoperability and the challenge of making up different healthcare actors in the telecare to improve the patient acceptation. Furthermore, the proposal looks for a video-conference system that presents a low CPU usage for the streaming negotiation and is based in well-known standard.

The first results showed that it is possible to implement a videoconference system overcoming the network configuration issues and running in a low cost device if no transcoding is required. This will allow an easy integration in our telecare system to achieve the goal of communicate patient with healthcare professionals and relatives for telecare services.

Some of the proposed future works are taking some measures of the AV system like delay and bandwidth; to complete system with other medical equipment and on-line/off-line checks to obtain a complete telemedicine system, testing the user usability and to make an acceptation study with real users in collaboration with health centers.

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